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REMARKS

The Official Action and the cited references have again been carefully reviewed. The review makes it clear that the claims, as amended, recite patentable subject matter and should be allowed. Reconsideration and allowance are therefore respectfully requested.

Prior to addressing the grounds upon which the rejections are founded, a summarization of the claimed matter will be advanced to make clearer the distinction between applicants' process for making thin film ZnO/Cu(InGa)Se₂ solar cells and the disclosures in the cited and applied references.

While the prior art disclose copper indium diselenide/zinc oxide heterojunction formations utilizing zinc oxide spray pyrolysis or ion beam sputtering, neither method results in a conversion efficiency of greater than about 2-3% - accordingly, these prior art methods do not disclose a commercially viable method for the replacement of CdS with zinc oxide in a thin film copper indium diselenide heterojunction cell characterized by high conversion efficiency without incurring the disadvantages of utilizing a CdS layer via wet chemistry, utilizing slow, batch processes, employing the highly toxic material of Cd, which escalates manufacturing costs as a result of handling and disposal of this hazardous waste.

The claimed process of applicants' is an improved process for making CuInGaSe₂ thin film solar cells with conversion efficiencies >2-3%, and yet avoids a need to deposit a buffer layer. This is apparent from the graph of FIG. 1 which shows current density versus voltage for CIGS thin film not subjected to an evaporant species of zinc acetate dihydrate and on which ZnO was sputter deposited to arrive at a conversion efficiency of only 1.8%.

By contrast, FIGS. 2, 3, 4, 6A-6G, 7A-7G, 8A-8F and 9 are graphs showing current density versus voltage for CIGS thin film subjected to an evaporant species of zinc acetate dihydrate followed by sputter depositing ZnO to provide conversion efficiencies ranging from 3.45 to about 13.1%.

Claims 18 and 19 were rejected as being anticipated by or in the alternative, obvious over Ramanathan et al. under 35 USC §102(b) and 35 USC §103(a).

Applicants respectfully traverse this rejection and request reconsideration for the following reasons:

A close review of WO 99/17377 to Ramanathan et al. shows that its process clearly lacks subjecting CuInGaSe₂ films to an evaporant species of zinc acetate dihydrate to dope the surface region n-type. Accordingly, this reference fails as a matter of law to anticipate applicants' claimed solar cells resulting from the process of claim 1.

Withdrawal of the rejection is respectfully requested.

Ramanathan et al. also fails to render the claims obvious. This is apparent because its process unmistakably entails:

- (a) depositing a first film of p-type copper indium diselenide film on a metal back contact;
- (b) depositing on the upper surface of the copper indium diselenide film a group II (a,b) and VII elemental salt;
- (c) converting the p-type of the upper copper indium diselenide film surface to n-type by thermal diffusion of the salt into the copper indium diselenide film;
- (d) depositing a second thin film layer of high resistivity zinc oxide; and

(e) depositing a third film of n-type transparent zinc oxide on the second thin film high resistivity zinc oxide layer.

Although Ramanathan et al.'s photovoltaic cell is cadmium free and eliminates the use of an interfacial extrinsic buffer layer, it lacks use of an evaporant species of zinc compound to dope $\text{CuInGa}(\text{Se}_2)$ with Zn and etching with acetic acid in an amount of about 50% by volume in water to remove ZnO, followed by sputter depositing ZnO on the Zn compound evaporant species treated layer of $\text{Cu}(\text{InGa})\text{Se}_2$. As unexpectedly shown in FIG. 1, when the CIGS film is not subjected to an evaporant species of zinc on which ZnO is sputter deposited, the current density versus voltage and the conversion efficiency is only 1.8% and therefore inferior to CIGS thin films treated by the invention process, as shown in the graphs of FIGS. 2, 3, 4, 6A-6G, 7A-7G, 8A-8F and FIG. 9.

There is no mention of or reference to use of subjecting $\text{CuInGa}(\text{Se}_2)$ to an evaporant species from a Zn compound to dope the CIGS with Zn and etching with acetic acid followed by sputter depositing ZnO in Ramanathan et al. having access to applicants' innovation via hindsight is not a permissible basis for speculation that it would be obvious from or equivalent to the photovoltaic cell of Ramanathan et. al.

Withdrawal of the rejection is respectfully requested.

Claims 1-3, 5, 18 and 19 were rejected as being unpatentable over Ramanathan et al. in view of Wright et al. and Yagi et al. under 35 USC 103(a).

Ramanathan et al. has been discussed above; however, it is reiterated that Ramanathan et al. clearly lacks applicants' steps c) and d).

The deficiencies enumerated in connection with Ramanathan et al. are not compensated for in the teachings of the secondary references of Wright et al. and Yagi et al.

Wright et al. unmistakably relates to forming relief images employing photosensitive microcapsules. And while it utilizes etchants for supports (such as zinc) that may be acetic acid, a skilled artisan in the art of making thin film solar cells would not look to the art of making relief images for solutions to eliminate the use of cadmium sulfide and its associated toxicity as a hazardous waste material and yet produce a CIGS thin film characterized by high conversion efficiency.

Further, it is emphasized that even if the acetic acid from the non-related subject matter of Wright et al. were substituted for the hydrochloric acid etchant agent in the process of Ramanathan, applicants' invention would still not result for the reason that Ramanathan et al. lacks use of an evaporant species from a zinc compound to dope a CIGS cell, as recited in applicants' claims.

Apparently, Yagi, et al. was utilized to bridge the deficiency of the combination of Ramanathan et al. and Wright; however, significantly, the combination of Ramanathan et al. and Wright still fails to teach applicants' steps (c) and (d) which entails subjecting the heated layer of CIGS to an evaporant species from zinc acetate dihydrate – which is an indispensable and critical step to achieving the unexpectedly high conversion efficiencies demonstrated in FIGS. 2, 3, 4, 6A-6G 7A-7G 8A-8F and 9 graphs showing current density versus voltage.

Accordingly, even if the aqueous acidic acid from the non-related method of manufacturing microactuator's of Yagi, et al. were combined with the combination of Ramanathan and Wright, applicants process for making thin film ZnO.Cu(InGa)Se_2 solar cells would not be produced nor made obvious.

Withdrawal of the rejection is respectfully requested.

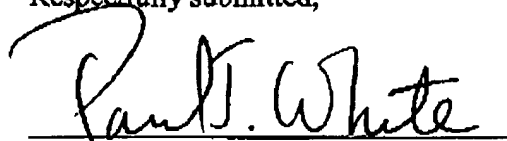
Note is taken of the objections raised to the specifications; however, in view of the amendments made to the specification, the objections are no longer applicable.

Similarly, note is taken of the rejections raised to claims 1-9 and 14-17 under the first and second paragraphs of 35 USC 112; however, in view of the amendments made to these claims, the rejections are no longer applicable.

Applicants acknowledge with appreciation, the indication that claims 4, 6-9 and 14-17 would be allowable to overcome the rejections under the first and second paragraphs of 35 USC 112 – and towards this end, applicants have amended main claim 1 to recite inclusion of zinc acetate dihydrate as the dopant and caused the remaining claims to depend there from (inclusive of the thin film solar cell of claim 18 which is now the product of the process of claim 1).

In view of the foregoing amendments, remarks and arguments, and in view of the unexpected showings of conversion efficiencies resulting from applicants process and products there from as demonstrated in Figs. 2, 3, 4, 6A-6G, 7A-7G, 8A-8F and 9, it is believed that the application is now in condition for allowance and early notification of the same is earnestly solicited. Applicant also submits a Petition and Fee Extension of Time. Applicant authorizes the Commissioner to charge any additional required fees to Deposit Account NO. 14-0460.

Respectfully submitted,



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